tions, seen stars well down toward the seventh magnitude.

The invisibility of stars of the seventh magnitude or slightly fainter is due mainly to the amount of light given by the background of the sky, even on the clearest nights and in regions well removed from the Milky Way (*cf.* papers by Professor Simon Newcomb, *Astroph. Jour.*, December, 1901; Dr. S. D. Townley, *Pub. A. S. P.*, No. 88, and G. J. Burns, *Astroph. Jour.*, October, 1902). At Professor Newcomb's suggestion Director Campbell has asked me to find my own limit of naked-eye vision, having given as artificial aids the direction of the star, and the screening off of the light of the sky.

Two blackened screens were attached to the twelve-inch telescope at a distance apart of 178 inches. The rear screen was pierced with an aperture half an inch in diameter and that at the object glass with one of one quarter of an inch. These apertures were so aligned that when a star was seen centrally through them it would be found at the intersection of the cross-wires of the three-inch finder. A movement of two or three minutes of arc was sufficient to carry the star out of the field thus formed.

The method of observation adopted was to clamp the telescope at the proper declination for the selected star. It was then swept slowly in right ascension with the eye at the aperture till the star was picked up. The position of the star was then noted in the finder and if not more than a minute or two of arc from the intersection of the cross-wires the observation was considered successful. Several such trials were made on each star.

Eleven stars were observed on three nights, of which only the last could be called a very clear night. The magnitudes of the stars employed ranged from 6.42 to 8.5. It was found that up to and including magnitude 8.0 the stars could be certainly seen in every instance, though in no sense easy objects. Stars of magnitudes 8.1, 8.2, 8.3 and 8.5 were seen with great difficulty and with occasional failures, generally when the eye was tired from the strain of searching for these very faint objects.

The contrast between the almost perfect darkness of the object glass screen and the sky immediately around it, as seen through the rear aperture, was very marked. It seems evident that for the observation of such faint objects without telescopic aid the screening off of the light of the sky is more important than the concentration of the vision in a definite direction as afforded by the use of the apertures.

HEBER D. CURTIS.

LICK OBSERVATORY,
April 22, 1903.

A MODIFICATION IN MEASURING CRANIAL CAPACITY.

ONE of the most important, but at the same time rather difficult and tiresome, manipulations in anthropometry is the measuring of cranial capacity. The importance of the measurement lies mainly in that it gives us the volume, as well as a fair basis for the calculation of the weight, of the brain, both of which data are very valuable in racial comparison, and, so far as most of the more primitive races of people are concerned, are quite impossible to be secured in any other manner.

It is plain that a procedure of such importance should be brought to the utmost possible simplicity and perfection, and so regulated that the capacity measurements could be utilized with full safety and universally. This sentiment was undoubtedly common to all the practical workers in physical anthropology up to the present day, and the results have been an invention of many more or less related methods for measuring cranial capacity, and a gradual approach to an ultimate, generally adoptable, procedure, under the circumstances the nearest possible to perfection. It is in connection with this very desirable, ultimate method, the main points of which are already well understood, that there is still a place for some modification, and one such will be described in this paper. In the first place, however, it is advisable to give a few explanatory notes as to the various procedures in general use.

The many methods of measuring cranial

capacity can be segregated into five groups, namely:

1. The skull is made impermeable and then filled with some liquid, preferably water, which is then weighed or measured; or the water is forced into a thin rubber bag until it fills with this the entire skull cavity, after which the liquid is measured. These methods, employed by Broca, Schmidt, Matthews, etc., yield good results, but are too complicated or tedious for ordinary use.

2. The skull is filled with sand or other substances, and this is weighed, the result giving a basis for calculating the capacity. This method, used especially by some American anthropologists of the last century, was not sufficiently accurate, and soon became obsolete.

3. The skull is filled with small, rounded seeds, beads, shot or other substance, and the contents are then measured (Tiedemann, Busk, Flower, etc.). The filling or the measuring (or both) is aided by certain manipulations (tilting, tapping, etc.), but, except the measuring vessels, no implements are required. The method in its numerous modifications is comparatively easy and has other advantages, but the results are mostly not as accurate as desirable.

4. The method invented and regulated by and named after Broca. In this procedure the skull is packed with shot, which is then measured; but both the filling and measuring are aided by certain implements, and every step of the procedure follows definite rules. Among the implements used appears a funnel of certain dimensions, which controls the flow of the shot. The method gives steady results, but can not be used with frail skulls, and the capacity obtained is always larger than actual, the proportion growing with the size of the skull.

3. The Welcker's method.* In this procedure, which is the outgrowth of the majority of those mentioned, but more directly of that of Broca, the most important part is delegated to the funnel, which, by its size, controls the measuring of the contents of the skull. The mode of filling the skull, so long as efficient and uniform, is immaterial; all that is required is that each worker should, with the aid of a standard skull, find the exact size of the funnel necessary to give him, in measuring, the correct result with his particular method and substance used for the filling of the skull. Any rounded seed or substance can be employed for the filling, as it is possible to completely fill the cranial cavity without using the process of jamming, such as that used by Broca; this allows the most fragile skull to be measured without any injury. Welcker advocated a funnel large enough to receive all the contents of the skull. The contents of the properly filled skull are emptied into a separate vessel and then 'with one movement is versed into the funnel,' which is open (not provided with any stopper) and held in position vertically and centrally above the graduated receiving vessel. Each new series of measurements is controlled by the standard skull.

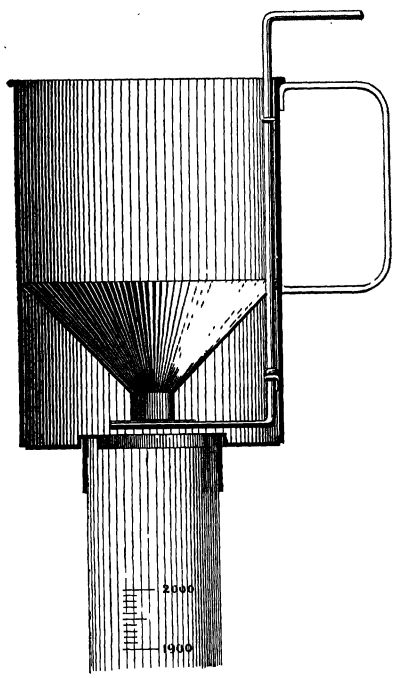
There can be no doubt that this last is the most advanced and preferable method, and the one which, a little more perfected, presents the best claim for universal adoption.

Experimenting for nearly six years, at the American Museum of Natural History, with the various earlier procedures of measuring cranial capacity, I arrived, a little over two years ago and practically independently, at a method which in principle is identical with that of Welcker, but is carried on with a few further helping details which deserve being mentioned.

Starting, as Welcker, with the laws concerning the flow of solid substances, etc., as laid down by Broca, and with Broca's implements and a standard skull, I was soon able to satisfy myself that: (*a*) The same substance poured through the same funnel with the same rapidity will always give the same, but with different rapidity will give differing, measures; and that (*b*) each different substance that can be utilized for the measurement of cranial ca-

* *Arch. f. Anthrop.*, Bd. XVI., S. 1 et seq. E. Schmidt, 'Anthropologische Methoden,' pp. 217–219. Recently a modification of the instruments with a form of a funnel stopper has been proposed by E. Landau, *Intern. Centralblatt f. Anthrop.*, etc., 1903, I., pp. 3–7.

pacity, flowing through a definite size funnel and with regulated rapidity, will give different results from those given by any other substance flowing through the same funnel and with equally regulated rapidity. (c) Given the same regulation of rapidity of the flow, there can be obtained, through the proper selection of funnels of different diameter, any measurement, ranging between the minimum and maximum of a substance of medium weight and size, by all the solid substances employable for filling the cranial cavity.



Without going into details, I may state that I obtained a very efficient regulation of the flow by adding to the funnel a movable stopper.* By doing this I found by many practical demonstrations that it becomes immaterial as to with what rapidity, or in what manner, the funnel is filled before opening the stopper. This removes at once all source of error connected with the emptying of the cranial contents, and allows us to dispense with the extra vessel used in measuring the cranial contents in Welcker's procedure. With the funnel closed, the cranial contents are poured into it entirely at the convenience of the measurer.

In 1901 I had constructed, mainly on the basis of Broca's, a special apparatus, of which a cut is inserted, and with this I have worked since with much ease and with entire satisfaction. My favorite mode of filling the skull is that used by Flower. To measure the contents, they are emptied directly, in any way desired, into a combination of a zinc vessel (higher than, but otherwise similar to, the standard Broca's double litre) and a removable funnel of 45° dip, with 15 mm. high vertical section, which, for my purpose (using old, dry mustard seed), is 20 mm. in diameter. Immediately below the funnel is a movable disk which acts as its stopper. The disk is attached to a rod which rises along the side of the vessel and above its border, and ends in a lever; by using this lever the disk closes or opens the funnel. A number of extra funnels, of the same dip but of different sizes, are provided, from which to choose if another substance than mustard seed is used for the filling. The vessel with the cranial contents is placed on the top of a 2,000-c.c. graduated glass tube (such as used by Ranke), which is fixed in a vertical position. The zinc vessel is provided with a groove in its bottom which exactly fits the border of the glass, the opening of the funnel being central. Then the lever is rapidly pushed to either side, opening the funnel at once and completely, and the flow left to itself; the level which the seed reaches (determined simply by the eye or, preferably, by the careful aid, without any shocks or pressure, of a niveau finder, such as comes with Ranke's tube) is the skull capacity. Thus the measuring part of the capacity determination is entirely reduced to a mechanical one, which not only makes it very easy, but eliminates from it all source of error due to personal equation. All that a student needs to learn is some method by which a complete and uniform filling of the skull can be effected, and then, working with the aid of the standard skull, choose the proper funnel; the rest is

* Landau's stopper differs in kind, but is apparently allied in purpose.

controlled. The results, always with the condition that the proper use is made of the standard skull, are as uniform and as near the reality as can be reasonably hoped for.

The apparatus I use is not made for the market, but it should not be difficult for any one sufficiently interested to have it constructed, following the given directions.

Aleš Hrdlicka.

U. S. National Museum.

NEW DEPARTURES IN THE CONCILIUM BIBLIOGRAPHICUM. II.—THE SUPPLEMENTARY BIBLIOGRAPHY.

This portion of the great catalogue exists primarily in manuscript form. As fast, however, as the demand for any part becomes great enough the cards are duplicated by a new lithographic process. Should the demand become still greater, typography would be resorted to. This ought certainly to be the case for the American section.

The references consist of such entries as can not for practical reasons be admitted into the general bibliography. The price of any given collection of cards is double that charged for the same number of cards taken from the main bibliography, ranging thus from half a cent to two cents a card.

1. *New Genera, Species, Subspecies, etc.*—As was shown in the first part of the present article, the Concilium adopted several years ago the uniform practice of reading, or at least perusing, the text of every publication entered in the bibliography. In this way the descriptions of all families, subfamilies, genera, subgenera, species, subspecies, etc., described in zoology passed before our eyes. It seemed under such circumstances a great pity that the information thus acquired should not be placed at the service of the zoological world. A beginning was made by referring to every new species under the appropriate genus name in connection with the printed cards. This has been made a permanent feature of the card catalogue, and no card is now issued which does not bring references to all new species described and to all new names introduced by the author. Many zoological memoirs contain descriptions of several hundred new species; but we have never wavered in our decision to record everything, even though double and triple cards were required.

The value of these entries is very great; but we have, of course, not been able to cite every species in full, nor to state the locality from which it came. Nor were the printed cards giving references to the new species available for an adequate catalogue of new species; for, in most cases, species from many different genera being described in a single publication these were recorded on a single card. In 1900 certain preliminary experiments were made in view of testing the possibility of placing all novelties on permanent record, so that, for example, a zoologist turning to the genus *Carabus* in the year 1950 might find before him in convenient form an exhaustive catalogue of every new subgenus, species and of every new name introduced under that genus since 1901. The value of such a record seemed to us quite inestimable and one can well imagine the feverish impatience with which the outcome of our experiments were awaited, for they were to decide whether this gigantic task lay within the possibilities of our organization. The experiments showed that the labor would in truth be immense. We also had to face the stubborn fact that we were working for posterity and that the full value of the work would not be appreciated for many years. We also knew that the entire work would be a complete financial loss. In view of all these facts it was, indeed, a bold decision which we took on January 1, 1901, when we began recording each novelty on a special card. The work is now progressing well, and if the Concilium be adequately supported, will never be abandoned.

The collection of references to such a genus as *Carabus* will not be the only facility which the Concilium will offer to the student coming to it in 1950. If a person is then desirous of studying the fauna of Bolivia, my successor in office will first show him the main printed bibliography, comprising at that date some 200 to 300 entries; he will then lead the visitor to a great cabinet of 72 drawers devoted to the new species described from South Amer-